TWO DIMENSIONAL AMORPHOUS SILICON IMAGE SENSOR ARRAYS

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ABSTRACT

Large two dimensional amorphous silicon image sensor arrays offer a new approach to electronic document input and x-ray imaging. The sensor array technology is now capable of image capture at greater than 10 frames/sec and with resolution of 200-400 spi. We describe our new high resolution imaging system, comprising a page-sized sensor array with nearly 3 million pixels, and the accompanying high speed read out and processing electronics. The key technological issues of pixel resolution, sensor fill factor, leakage currents and noise are reviewed. Measurements of a new array architecture are described, in which the sensor is formed as a single continuous film on top of the matrix addressing components.

INTRODUCTION

Two dimensional amorphous silicon image sensor arrays have been fabricated and studied for about the past 5 years [1-5]. During this period of time, the number of pixels and overall imager area have increased 100-1000 times. The first such arrays that were made at Xerox PARC contained 2560 pixels, with a size of about 1"x1", while our most recent arrays have nearly 3×10^6 pixels and measure approximately 8"x10". However, the general architecture of the array has not changed substantially, and is a matrix addressed structure in which each pixel contains a thin film transistor (TFT) and a p-i-n sensor made of a-Si:H, together with metal bus lines for addressing and applying bias to the sensor.

The anticipated applications of these arrays for document scanning and x-ray imaging are well established, and have been widely discussed [1-8]. Document scanners have moderate noise requirements, since the large area array is intrinsically much more sensitive than the more conventional linear scanners. On the other hand the resolution requirements are challenging since the present scanner standard is 300 spot per inch (spi) and resolution of 600 spi or more is desirable. Most x-ray medical imaging applications do not require such high resolution, due to the lack of fine detail in the the human body, and because the modulation transfer function (MTF) of the imager is already limited by the phosphor screen that converts the absorbed x-ray energy into detectable light. On the other hand a high dynamic range is important, and the critical medical requirement of minimal x-ray dose to the patient creates the need for very low noise operation. Noise levels of about 1000 electrons appear to be achievable, consistent with the formation of an image limited only by the statistical noise of the incident x-ray photon flux over most of the intensity range of interest.

The next section briefly describes the most recent imaging system that we have fabricated. We then discuss some of the design issues which apply particularly to the performance of large area and high resolution imagers, and present results on new array architectures that might lead to improved imager performance. Those features of the imager that relate to amorphous silicon material properties are emphasized.

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